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## SPECIFICATION

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TYPE 1350 ST STEREO COMPARATOR

1. GENERAL

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- 1.1 The [ ] Type 1350 ST Stereo Comparator is used for precise coordinate measurements on large sizes of stereoscopic pairs on photographic film or plates.
- 1.2 The comparator consists essentially of a dual mechanical stage assembly employing precision lead screws and ways giving independent longitudinal slide movements of 500 mm and cross slide movements of 250 mm perpendicular to the longitudinal slides, a means for holding the plates or film for measurement, necessary reading dials, and light sources and optics for stereo viewing. The instrument is supported by a special console which also serves as a housing for the associated electronic systems. The instrument accepts stereo pairs of cut film or plates up to 10 x 20 x 1/4 inches. Each stage assembly measures the full area of 500 mm in "X" and 250 mm in "Y" direct to one micrometer least count.
- 1.3 Design and materials used are in accordance with the best engineering practices consistent with precision instrument manufacture.

2. SPECIFIC

- 2.1 The base is a single casting designed for lightness, strength, and dimensional stability and has the longitudinal (X axis) ways in its upper surface.
- 2.2 The cross slide (Y axis) ways are integral with a bridge structure mounted from the base and provide cross slide travels at right angles to the longitudinal slide to plus or minus 10 sec of arc.
- 2.3 The precision lead screws of the longitudinal slides and of the cross slides have a pitch of one millimeter and a lead of five millimeters thus providing a 5 mm motion of the stage with one revolution of the lead screw. The screws are precision cut and lapped for accuracy, and mounted on super precision ball bearings.

NGA Review Complete

- 2.4 The longitudinal stages support the plates or film to be measured on their upper surfaces. The openings through the stages are sufficient to permit a measurable area of 500 mm by 250 mm. Each X axis stage carries a pivot table ( $\pm 2^\circ$  pivot) on its upper surface. Glass plates, inset into the upper surface of these pivot tables serve as the support plates for the film or plate. A pair of manually operated pressure platens are provided to level the film for measurement. Removal of the pressure platen permits the mounting of photographic plates.
- 2.5 The measuring stages are remotely controlled from the operator's console through velocity servo drives connected to each lead screw. Provision is made for continuously variable drive speeds from about five millimeter per minute to a maximum slew speed of 15 mm per second for each set of X and Y screws. This slew mode is controlled by a single "joystick". Individual fine setting is accomplished through the use of four handwheels at the operator's console. Switch positions permit the following motions.
- |                         |                                     |
|-------------------------|-------------------------------------|
| a. Joystick (slew)      | Stages X and Y                      |
| b. Joystick (slew)      | Stages X' and Y'                    |
| c. Joystick (slew)      | Stages X, X' and Y, Y' together     |
| d. Handwheel (fine set) | Stages X, X' and Y, Y' individually |
| e. Handwheel (fine set) | Stages X, X' and Y, Y' together     |
- 2.6 In power operation, the full system is protected by safety limit micro-switches. For mechanical operation, mechanical stops are provided to prevent overtravel of any stage.
- 2.7 In accordance with human engineering design, handwheels are provided at the console to allow the operator an individual manual control of both sets of X and Y motions.
- 2.8 Located at one end of each lead screw is a graduated metal dial and vernier for indicating the stage position directly to 0.001 mm. A mechanical counter is provided with each motion to determine accumulated turns of each lead screw.
- 2.9 The X axis stages are supported on super precision ball bearings selected by individual tests. The guidance of the stages along the ways is achieved by the use of preloaded shoes of a low coefficient-of-friction material. The Y axis stages are high precision ball bearing

slide construction.

- 2.10 The viewing system has stereoscopic zoom capability. The ocular system is inclined to the stages at a comfortable angle for operator use, but views the films vertically through carefully mounted optical systems carried by each Y axis stage. A 2X zoom feature in each leg renders the magnification variable from approximately 5X to 40X in overlapping ranges with appropriate changes of optics.

Each leg of the stereo optical train contains a four position reticle turret. The reticle patterns shall be as follows:

dashed-line closed-center cross  
solid cross  
parallel lines crossed  
blank

The reticle line width subtends approximately eight micrometers at the film or object plane at all magnifications. In addition, each leg has provision for 180 degrees of image rotation before the reticle plane by the use of Pechan prisms. This motion has a circle graduated in one degree increments and a reference mark is provided for identification. For maximum accuracy of measurement, the rotation adjustment should not be changed during a measurement sequence.

The eyepiece focus controls are independent and have an interpupillary distance, adjustable from 55 to 72 millimeters.

The zoom feature, the interpupillary distance adjustment, and the eyepiece focus adjustment have no effect on the pointing accuracy and may be changed during measurement.

- 2.11 The illuminators for the stereo viewing system utilize tungsten light sources filtered to a band corresponding to maximum visual response for maximum contrast and reduced secondary spectrum. Intensities of the light beams are individually varied through transformer controls. Each illuminator is matched to the maximum numerical aperture of the stereo observing system to optimize resolution.
- 2.12 The temperature rise at the focal plane due to the light source does not exceed 2°F above the ambient temperature.

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- 2.13 Substage illumination for each stage is provided to aid the operator in locating points to be measured.
- 2.14 Both sets of X and Y axis lead screws of the comparator are connected to [ ] Type H1045 reading heads. The reading heads, geared from the lead screws, provide a least count capability of one micrometer.
- 2.15 A specially designed console is furnished to support and protect the instrument. Tailored to the comparator design, this console compliments the other features of the instrument. As well, all electronic assemblies are housed in this console conserving floor space.
- 2.16 Incorporating the finest of materials and workmanship, the comparator represents the culmination of years of leadership by the [ ] in the manufacture of precision screw comparators. It is painted [ ] Instrument Grey with all other finished surfaces treated by nickel, anodizing, and standard protective surface treatment processes where possible.

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### 3. ACCURACY

- 3.1 Exclusive of the quality of the image being read and human error, the overall accuracy of the instrument is as follows:

The actual stage position at any millimeter interval in its travel in the measuring direction shall not deviate from the position indicated by the reading dials by more than .002 mm or .001% of travel, whichever is greater. The measuring direction of [ ] Comparators is with the stages traveling toward the dials.

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- 3.2 The instrument calibration is referenced to 68°F.
- 3.3 The Y axis motions shall be orthogonal to the X axis motions to plus or minus 10 sec of arc.

### 4. DIGITIZATION

- 4.1 A modified [ ] Type 1045 Data Logger digitally encodes both sets of X and Y coordinate values measured by the comparator. On read-out command, it generates electrical signals to cause the output device to punch the digital X and Y coordinate values with other data as specified below.

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4.2 The Data Logger system consists of four pulse generator type reading heads, an electronic unit, a footswitch, and an output circuit for coupling to an IBM 526 Card Punch furnished by the customer (output to other devices quoted on request).

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4.3 The ☐ Type H1045 reading heads are mounted on the measuring comparator and coupled to the four lead screws through high precision gears. The reading heads furnish electrical signals to the electronic unit for digitally encoding the X and Y coordinates.

4.4 The resolution of the encoding process shall be 1,000 counts per turn of the encoder, corresponding to a least count of one micrometer in each coordinate.

4.5 Each of the X and Y coordinates is encoded into a six-decimal digit number corresponding to the position of the stage expressed in micrometers. Negative coordinate values are indicated as complement numbers. For example, -0.001 mm is indicated as 999.999 mm.

4.6 A six-decimal-digit counter is provided, which maintains a count of the number of printing or punching cycles that have occurred.

4.7 Three registers of six-decimal each are provided for storing manually-inserted numerical data that is desired to be punched with the coordinate values and frame count.

4.8 A keyboard is provided for setting the X and Y registers, frame counter, and identity registers to any desired initial values. Ten keys are used for setting in digits 0 to 9. In addition, two keys are provided for setting in space and end characters for modifying the output format.

Pushbuttons are provided for selecting the register which is to be set, and these same buttons are used for selecting the register whose contents are to be displayed.

4.9 Four six-decimal-digit, in-line, single-plane illuminated digital displays are located convenient to the operator. These displays indicate the value of the X and Y coordinates as contained in the corresponding register, frame count, or the contents of one of the identity registers. The display for the right hand set of stages shall be at the operator's right hand, similarly, on the left for the left hand set of stages.

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 Type 1350 ST Specification, contd.

- 4.10 A footswitch is provided for starting the readout cycle. When this control is pressed and released, the digital values of the X and Y coordinates, the frame count, and the contents of the identity registers are set automatically into a buffer register, and signals are generated to cause punching of the data as set in this register. On each punching cycle, the frame count advances automatically one unit.

While the data in the buffer register are being punched, it is possible to set the comparator to new coordinates or to set new values into the X, Y, frame count, or identity registers. Movement of the lead screws at any time, including movement after the punching cycle is initiated, does not cause incorrect readings or other anomalous performance.

- 4.11 Lead screw slow speeds of approximately three revolution per second in either direction are possible, without exceeding the count rate of the digitizing system.
- 4.12 For each of the two sets of stages, the values of X, Y, frame count, and identity-digits are punched in the following order, with the highest-order digit of each word first:

6 digits of X, space,  
6 digits of Y, space  
6 digits of frame count, space  
identity digits 1 - 6, space,  
identity digits 7 - 12, space,  
identity digits 13 - 18, end pulse (carriage return).

If an end character is inserted as a digit in one of the identity registers, an end pulse shall be generated and the punching cycle shall terminate at that point.

- 4.13 The readout rate is approximately ten digits per second.
- 4.14 Transistor circuits are used. No electron tubes, gas discharge tubes, or stepping switches are employed. To facilitate servicing, plug-in circuit board construction is used.
- 4.15 The Data Logger is ready for use immediately (within two seconds) after power is turned on.

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- 4.16 Electrical noise and magnetic fields normally encountered in a laboratory, such as those produced when switching motors and flourescent lamps, have no effect on operation of the Data Logger.
- 4.17 Installation and use of the Data Logger has negligible effect on the accuracy of the comparator. The digitized reading will remain within two bits or counts of the comparator dial reading.
- 4.18 For each of the two sets of stages, a plug-in board wired to allow reading out the six words as six-digits each in any word order specified is provided. The order is subject only to the restriction that one of the coordinates, X or Y, must be in an odd numbered position in that order, and the other coordinate must be in an even numbered position. The board also provides for setting the number of digits over which "carries" are propagated in the frame count. The rest of the digits in the frame count word may be deleted or used for additional identity data.
- 4.19 General Data

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- 4.19.1 The [ ] reserves the right to depart from the detailed specification of the system when improvement in performance can be realized.
- 4.19.2 Environmental Requirements: Precise measurement is a function not only of the instrument design and the operator's experience but also of the ambient environmental conditions to which the instrument is subjected. We recommend, therefore, that the [ ] Type 1350 ST Comparator be used in a closely controlled environment at an ambient temperature of  $70^{\circ}\text{F} \pm 1^{\circ}\text{F}$  and a relative humidity of  $50\% \pm 5\%$ .
- 4.19.3 The power requirement for the entire system is: 115 volts, 10 amps, 60 cycle single phase.
- 4.19.4 The approximate net weight is 3300 lbs.

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